REVIEW ARTICLE

Importance of Probiotics in Orthodontics

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ABSTRACT

White spot lesion (WSL) development of the enamel surface is by far the most important iatrogenic effect of fixed orthodontic appliance therapy and can have lasting negative effects on dental esthetics. The complex design of orthodontic bands and brackets may create an ecological environment that facilitates the establishment and growth of cariogenic mutans streptococci strains which are prominent among WSL causative organisms. They are most prevalent around the cervical region of bands in the posterior region, whereas in the anterior region, the lateral incisors in both arches, followed by the canines, are most commonly affected. Various antimicrobials are used to prevent WSL but are not effective long-term unless their application is periodically repeated. Probiotics are live microorganisms which when administered in adequate amounts (in food or as a dietary supplement) confer a health benefit on the host. Various studies have shown that the use of oral probiotics is associated with prevention of white spot lesions and improvement in periodontal health.

Keywords: White spot lesions, *S mutans*, Probiotics.

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INTRODUCTION

Not all outcomes in orthodontics are positive. Enamel demineralization clinically visible as white spot lesions (WSLs)[1] are one of the most common adverse effects of orthodontic treatment and can have lasting negative effects on dental esthetics. White spot lesion is a broad term that includes:

- Developmental enamel lesions (fluorosis, enamel hypoplasia, etc.)
- Localized areas of demineralization/caries in nonorthodontic patients
- Localized areas of demineralization/caries related to orthodontic appliances.

White spot lesion development of the enamel surface is by far the most important iatrogenic effect of fixed orthodontic appliance therapy.[2] This phenomenon has become a clinical problem since directly bonded orthodontic brackets were introduced.[3] Furthermore, the complex design of orthodontic bands and brackets may create an ecological environment that facilitates the establishment and growth of cariogenic mutans streptococci strains.[4] The prevalence of WSLs is reported to vary from 4.9[5] to 84%[6] of tooth surfaces. In a longitudinal study, Mitchell[7] found an overall prevalence of 18.5% of tooth surfaces and reported that the average percentage of tooth surface area affected was 1.6%. Mizrahi[6] showed a high prevalence of 84%, which reflected the fact that he measured all (pre- and posttreatment) white enamel lesions and his results may have been affected by this patient group having a greater number of demineralized white lesions caused by local environmental effects.

When basic oral hygiene is poor, orthodontic appliances create areas of plaque stagnation, especially around brackets, bands, wires, and other attachments; this facilitates the development of WSLs.[8] Levels of acidogenic bacteria, present in the plaque, notably *Streptococcus mutans*, are higher in orthodontic patients than in nonorthodontic patients.[9,10] This causes demineralization around the brackets and leads to WSLs. The demineralization of enamel, a precursor of carious lesion, appears opaque because of the decreased light-scattering ability of the decalcified enamel. The appearance is caused by an optical phenomenon owing to subsurface tissue loss and is exaggerated by thorough drying. They are most prevalent around the cervical region of bands in the posterior region, whereas in the anterior region, the lateral incisors in both arches, followed by the canines, are most commonly affected.[8] In the anterior region, the lateral incisors are the most susceptible because of decreased salivary clearance and also less space between the bracket and gingiva.[5] This creates less accessibility for oral hygiene techniques. White spot lesions in the anterior region are clearly visible and can cause esthetic problems after orthodontic treatment.

Among the many orthodontic appliances, brackets can play a key role in enamel demineralization because their complex designs increase the retention of food particles and dental plaque by impeding access to the tooth surfaces for cleaning. A previous report showed that extensive plaque accumulation is associated with

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bonded orthodontic brackets,[11] and a fixed appliance with orthodontic brackets causes specific changes in the oral environment, such as decreased pH and increased plaque accumulation. The bacterial adhesion to orthodontic brackets can be the primary step leading to pathogenic plaque formation and enamel demineralization around orthodontic brackets, because the adhering bacteria continue to grow on the tooth surfaces near the brackets. In particular, metallic brackets are known to have the highest critical surface tension and have increased risk for enamel demineralization.[12,13] This indicates that orthodontic brackets can impose a potential risk for enamel demineralization.

Enamel demineralization is caused by organic acids produced mainly by *S. mutans*, which are known to be the prime causative organism of dental caries. Of these species, *S. mutans* and *Streptococcus sobrinus* are the most frequently isolated from human oral cavities and have been implicated as the main causative organisms of dental caries.[14,15] During orthodontic treatment, fluoride can be administered to the teeth in various ways, including topical (fluoridated toothpaste, mouthrinse, gel, and varnish) and adhesive (fluoride-releasing cements and elastomeric modules and chains) methods. Many other methods, including antimicrobial and antibiotic therapies, have been tried, but their efficiency lasts only as long as they are supplied at regular intervals.[16] These disadvantages have caused probiotics to be considered an efficient alternative that could be available in regular dietary supplements without causing major side effects.

"Antimicrobials" are other chemical agents that kill or debilitate the infection of interest, like iodine. Both antibiotics and antimicrobials have been used to treat the dental caries infections. Whether we choose chlorhexidine, povidone iodine, fluoride, penicillin, or other antimicrobials/antibiotics, these agents kill a broad spectrum of organisms. They may be semiselective in that we can prescribe medicaments that preferentially affect Gram(+), Gram(–), anaerobic, or aerobic organisms, but they still kill an array of like organisms.

Thus, we must conclude that broad-spectrum antibiotics or antimicrobials are not effective in the long term unless their application is periodically repeated. This repeated suppression can be effective as long as resistant strains of the bacterial pathogens do not develop and no yeast infections develop because of suppression of the normal flora.

PROBIOTICS

To overcome the limitations of the traditional disease management strategies, a number of researchers are developing "probiotic" methods to treat the caries causing infection. Probiotics were defined by FAO/WHO (The Food Agricultural Organization/World Health Organization) as live microorganisms that, when administered in adequate amounts (in food or as a dietary supplement), confer a health benefit on the host (improving microbiological balance in intestinal tract).[17,18] Such nonpathogenic organisms (yeast or bacteria, particularly lactic acid bacteria) are present in food, and can have a favorable impact on host health. Probiotics have been used for decades in fermented products, but potential use of probiotics as a nutritional medical therapy has not been formally acknowledged.[18]

Elei Metchnikoff was the first to state that probiotics could provide a health benefit, and proposed that Bulgarian people had a longer longevity due to consumption of fermented milk containing viable bacteria. The term "probiotic," as opposed to "antibiotic," was initially proposed by Lilley and Stillwell in 1965. First probiotic species to be introduced in research was *Lactobacillus acidophilus* by Hull et al in 1984, followed by *Bifidobacterium bifidum* by Holcombh et al in 1991.[19]

"Probiotic," as it is called here, means mechanisms are employed to selectively remove only the (odonto) pathogen while leaving the remainder of the oral ecosystem intact. When the term is defined as "medical probiotics" (microbial preparation) or "other probiotics" (functional food), probiotics are provided in products in one of four basic ways:

- As a culture concentrate added to a beverage or food (such as fruit juice)
- Inoculated into prebiotic fibers
- Inoculated into a milk-based food (dairy products such as milk, milk drink, yoghurt, yoghurt drink, cheese, kefir, biodrink) and
- As concentrated and dried cells packaged as dietary supplements (nondairy products such as powder, capsule, gelatin tablets).

The use of probiotics has taken giant leaps since the 20th century. Probiotics have been used in modifying the microbial flora of the stomach and intestines. Probiotics can create a biofilm, acting as a protective lining for oral tissues against oral diseases by keeping the bacterial pathogens off oral tissues by filling the spaces where the pathogens would invade.[20,21] Some probiotic species also secrete antimicrobial compounds called bacteriocins, for example, reuterin.[22,23]

Criteria for Probiotics

To be considered for use as probiotic, the following criteria need to be fulfilled:[24]

- It should be capable of exerting a beneficial effect on the host animal, e.g., increased growth or resistance to disease

- It should be of human origin
- It should have high cell viability
- It should be nonpathogenic and nontoxic
- It should be able to interact with, or to send signals to, immune cells
- It should have capacity to influence local metabolic activity
- It should be capable of surviving and metabolizing in the gut environment, e.g., resistance to low pH and organic acids.
- It should be stable and capable of remaining viable for periods under storage and field conditions.

Mechanisms of Action of Probiotics

Probiotics can help prevent and treat disease through several mechanisms including direct interaction, competitive exclusion, and modulation of host immune response. The treatment strategies conferred by probiotics are mainly anticipated to be either by inhibition of specific pathogens or by altering the host immune response through the following multiple factors.[24]

Inhibition of Specific Organisms

- Inhibition of pathogen adhesion, colonization, and biofilm formation
- Inhibition of pathogen growth by various substances, such as organic acids, hydrogen peroxide, and bacteriocins against oral pathogens

Effects on Host Response

- Inhibition of collagenases and reduction of inflammation-associated molecules
- Induction of expression of cytoprotective proteins on host cell surfaces
- Modulation of proinflammatory pathways induced by pathogens
- Prevention of cytokine-induced apoptosis
- Modulation of host immune response.

Evidence for use of Probiotics in Orthodontics

Review of literature revealed that some studies have been conducted on the prevalence, role, and effects of probiotic bacteria in orthodontics. A study by Cildir et al,[25] in which the effect of probiotic yogurt was evaluated on *S. mutans* counts in the saliva of orthodontic patients, showed that the number of subjects with high *S. mutans* counts decreased from 63 to 21% after 2 weeks of consumption. Many studies have used saliva to determine the amounts of *S. mutans* in the oral cavity.[23,26-28] The major disadvantage of using saliva is that the *S. mutans* in the saliva is a total count of the organisms in the oral cavity from previous carious lesions, the tongue, and other sites that harbor the organisms, and it is not specific to the tooth surface. Some studies have shown a difference between the salivary *S. mutans* counts and the *S. mutans* counts in plaque.[29,30]

A few studies have evaluated the effects of local administration of probiotic agents, such as mouthwashes,[31] lozenges,[28] tablets, straws,[27] milk,[32-34] cheese,[26] ice cream,[35] chewing gums,[36] yogurt,[25,27] chocolate,[35] curd,[38] and other supplements and have found that these have a beneficial effect on oral health. The benefits on oral health in preventing WSLs and caries[27] have been recognized, and thus probiotics have been incorporated into mouthwashes and dentifrices for popular consumption.

Other uses of Probiotics in Oral Cavity

Apart from orthodontics, other dental specialties also have studied the effects or probiotics and have concluded some positive effects. Taking into account the two major treatment strategies against periodontal diseases, namely the elimination of specific pathogens and the suppression of a destructive host response, the probiotic approach may add value in achieving these treatment goals. Several studies have concluded that there are positive effects of probiotics on gingivitis,[39,40] periodontitis,[41,42] halitosis,[43] and candidiasis[44] as well along with their anticaries effect.

CONCLUSION

Various studies have shown that the use of oral probiotics is associated with prevention of WSLs and improvement in periodontal health. More research and clinical trials will facilitate identification of the probiotics that are best suited to oral use, as well as the most appropriate vehicles: food products (cheese, milk, yogurt) or supplements (chewing gum, lozenges). The existence of probiotics in the indigenous oral microflora of humans needs exploration because these bacteria offer the advantage of being perfectly adapted to the human oral ecosystem. Understanding probiotic action may permit modulation of the immune system, both locally, and systemically. Knowledge of probiotics on the host immune system has entered a new and fascinating phase of research, and progression in this field is likely to offer novel and useful means to modulate host immunity for protection from, or treatment of, a wide variety of oral diseases and disorders.

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